DOCUMENT RESUME

ED 155 010 SE 024 239

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TITLE An Introduction to the Fundamentals of Chemistry for the Marine Engineer - An Audio-Tutorial Correspondence Course (CH-1C).
PUB DATE Jun 78
NOTE 18p.; For related document, see ED 148 620

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Chemical Reactions; *Chemistry; *Engineering Education; *Instructional Materials; Marine Biology; Oceanology; *Science Courses; Science Education; Science Units; *Study Guides

ABSTRACT

This document provides a study guide for a three-credit-hour fundamentals of chemistry course for marine engineer majors. The course is composed of 17 minicourses including: chemical reactions, atomic theory, solutions, corrosion, organic chemistry, water pollution, metric system, and remedial mathematics skills. Course grading, objectives, administration, sample exam, and minicourse outlines are included. (SL)

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AN INTRODUCTION TO THE FUNDAMENTALS OF CHEMISTRY FOR THE MARINE ENGINEER - AN AUDIO-TUTORIAL CORRESPONDENCE COURSE (CH-1C)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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June - 1978

SE 024 239

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INTRODUCTION

An Introduction To The Fundamentals of Chemistry For The Maine Engineer is a three-credit-hour, college-level correspondence course offered through Maine Maritime Academy's Division of Continuing Education. It is, essentially, the same course that has been offered for the past several years to Maine Maritime Academy students working toward a degree in Marine Engineering. The course has no prerequisites. It is composed of a series of minicourses which are sequential, self-paced, and designed in the audio/tutorial format. In addition, the course is contract graded. This means that the student decides upon the competency level he or she wishes to attain - competency levels are attained and demonstrated by successfully completing specific minicourses - then proceeds to attain that level, using the audio/tutorial approach.

The course is a combination of lecture and laboratory study. Lectures and discussions of the various concepts are presented to the student via audio-tape, and essential features are emphasized with 35mm slides, laboratory activities, through the use of student texts, and through the use of individual minicourse study guides. For students who prefer to read rather than listen, tapescripts are available - the tapescripts contain exactly the same information as do the tapes. Students also have the option to read and listen at the same time. When laboratory activities are encountered, the student is expected to stop, conduct the activity, gather necessary data, and then proceed.

The course is composed of seventeen minicourses. Nine of the minicourses are required in order to attain the various competency levels (D level, C level, B level, A level). In addition, there are three elective minicourses, and five minicourses which attend to remedial mathematics skills. The minicourses are titled:

MINICOURSE	TITLE
D-1	Elementary Background
D-2	Chemical Reactions
D-3	Quantitative Relationships
C-1	Advanced Chemical Reactions
C-2	Atomic Theory
C-3	Solutions
C-4	Corrosion
B-1	Low Pressure Boiler Water Treatment
A-1	High Pressure Boiler Water Treatment
E-1	Organic Chemistry
E-2	Toxic Substances
E-3	Water Pollution and Waste Treatment
R-1	Metric System
R-2	Significant Figures
R-3	Scientific Notation - Exponential Form
R-4	Algebraic Operations
R-5	Logarithms

Successful completion of the course at the A-competency level requires approximately six to eight hours of study each week, for a period of fifteen weeks. This, however, should be used only as a guide; the student need not necessarily complete the course in

fifteen weeks. Additional time requirement information is provided in the "Course Administration" section of the syllabus.

OBJECTIVES

The general objectives of the course are listed below. Specific behavorial objectives for the various minicourses are listed in the individual minicourse study guides.

(1) To introduce the student to the fundamentals of chemistry.

(2) To provide the student with basic skills in the area of boiler water analysis tests.

(3) To provide the student with a basic understanding of the problems caused by faulty boiler water treatment.

(4) To provide the student with an understanding of the types of boiler water treatments that will minimize damage to boiler parts by the mineral content of water, and maximize the life of a ship's boilers.

COURSE ADMINISTRATION

The course is administered by and through the Academy's "Division of Continuing Education." Course grading, correction of examinations, and correspondence concerning problems and questions about course content and materials are handled by your instructor (the instructor's name is provided in the "Instructor's Cover Letter" which accompanied this syllabus.) In the event that you encounter problems, or otherwise have questions, you should correspond directly with your instructor. Your instructor may also be reached by telephone at 207-326-4311.

Payment of course fees is made through the Director of

Continuing Education. The total course fee is computed on a per-credit-hour basis, plus a registration fee, an administration fee, and fees for books and materials which become the personal property of the enrollee. Since the amounts of these fees are subject to change from time-to-time, they have been listed on a separate sheet.

Upon completion of the course, the student's course grade is filed with the Academy's Registrar's Office and becomes part of that student's permanent record at the Academy. In addition, notice of course completion and a final grade are forwarded to the student. If, at a later date, the student desires a copy of his or her grade, a request for a copy of the student's official transcript should be made in writing to the Academy Registrar.

COURSE EQUIPMENT

The course has been designed to address the needs of sea-going, marine engineering personnel. Further, it has been designed for use by these types of people during their off-duty hours at sea. While the intended audience is marine personnel who are at sea, the course is not restricted to people in these categories. In fact, the course is open to all who are interested; however, the availability of equipment may alter the instructional mode somewhat.

The audio/tutorial format of instruction requires the use of several mechanical and physical items. Those items are a 35mm slide projector, an audio cassette tape player, at least one slide carousel, a set of slides for each minicourse, and equipment necessary for the successful conduct of the various lab activities. During the design phase of the course, certain assumptions were made concerning these equipments. First, shipping companies

interested in making the course available to their crews, or shipping companies whose crews so requested, would purchase the basic equipment package. This package includes - #1, one 35mm slide projector; #2, one audio cassette tape player; #3, two audio cassette tapes for each of the inclusive minicourses; #4, one set of 35mm slides for each of the inclusive minicourses; #5, one 35mm slide carousel; #6, two copies of each of the minicourse tapescripts; #7, one set of necessary laboratory equipment; #8, two minicourse study guides for each of the minicourses. Second, that the cost of course enrollement, administration, texts, and chemicals would be borne by the enrollee unless company Continuing Education programs allowed for such payments.

Several alternatives exist for those with insufficient funds to purchase the equipment package - perhaps those who are not in the employ of the marine industry. The minicourse tapes and study guides may be purchased separately, as well as may the course slides and audio-tapes, and laboratory equipment package. This cuts the cost substantially for those who already have equipment at their disposal (personal equipment, equipment at a local library's or a university's learning center, etc.). For those of lesser means another alternative exists.

Minicourse tapescripts have been printed in a fashion which allowed inclusion of drawings of each of the included slides. This means that each tapescript includes the exact information that one would obtain from listening to a tape and viewing the respective set of slides. However, the course was designed to accomodate the greatest variety of learning styles (learning style here is defined as the method by which a student chooses to study from amongst

those available). Having only the tapescript available for study will limit the student to this instructional mode. Studying only the tapescript deprives the student of the useful hands-on experience gained from conducting the laboratory exercises.

One final equipment package arrangement is available. Equipment packages may be rented on a per month basis, and a fee paid for breakage.

All of the individual prices, package prices, and rental fees are contained in a separate "Equipment Fees Listing."

COURSE GRADE

The course grade is determined by contract. That is, the student decides the competency level (D, C, B, A) he or she wishes to attain, and then contracts to do the work necessary to attain that level.

The grading policy is open-ended. The student is expected to fill out a grade contract before taking the D-1 minicourse examination. However, if at some later date the original grade contract is found to have been unrealistic, the student may down-contract (lower the level of expected competency). This is accomplished by requesting and subsequently submitting a second grade contract. If, on the other hand, the original contracted grade was too low, the contract may be raised.

The following are established as minimums:

COMPETENCY LEVEL	REQUIREMENT
D	If the student wishes to attain the D competency level (a D-level contract) minicourses D-1, D-2, and D-3 must be successfully completed.

C	A grade of C requires that the student successfully complete minicourses D-1, D-2, D-3, C-1, C-2, C-3, and C-4.
B	In order to obtain a grade of B, the student must meet the requirements for the D and C grades and, in addition, complete minicourse B-1 and two elective minicourses (E-1 through E-3).
A	A grade of A requires meeting the requirements for the grades of D, C, and B. In addition, minicourse A-1 and the remaining elective minicourse must be completed.

SAMPLE GRADING CONTRACT FOR CH-1C

The course grade will be determined by contract.

1. For a grade of D, minicourses D-1, D-2, and D-3 must be completed.

2. For a grade of C, minicourses D-1, D-2, D-3, C-1, C-2, C-3, and C-4 must be completed.

3. For a grade of B, minicourses D-1, D-2, D-3, C-1, C-2, C-3, C-4, B-1, and two E-level minicourses must be completed.

4. For a grade of A, all of the minicourses except the R's must be completed.

The student may up- or down-contract at any time.

NAME _____ DATE _____

STUDENT IDENTIFICATION NUMBER _____

I WISH TO WORK FOR THE GRADE OF _____

EXAMINATIONS

After the student has completed what he or she considers to be sufficient study of a minicourse, the instructor should be contacted concerning an examination over the material covered in the minicourse.

This is done by submitting a "Request For End Of Minicourse Examination" form. A sample form is shown below.

SAMPLE REQUEST FOR END OF MINICOURSE EXAMINATION FORM

1. I have completed my study of minicourse _____ (course number), and am ready to take the end-of-course examination.

2. The exam should be sent to _____ (Name, address, and title of official who will administer the examination)

3. Date of request _____

4. Signature of student _____

5. Student Identification Number _____

Notice that item number 2 on the sample form requires the title of the individual who is to administer the examination. The following individuals may administer end-of-minicourse examinations:

1. On merchant vessels - the Chief Mate, Chief Engineer, and Master.
2. Any military education officer.
3. Any school guidance counselor.
4. Any high school principal or vice principal.
5. Any minister, priest, or rabbi.
6. The Academic Dean at any post-secondary institution.

It is the student's obligation to locate a test administrator and, any cost incurred in this regard will be borne by the student.

End-of-minicourse examinations will be mailed directly to the individual so designated on the student's request form. Upon completion of the examination the person in charge of administration

will mail the examination directly back to the course instructor. After the examination has been graded, the results will be mailed to the student.

The examinations include essay questions, computation questions, short-answer items, and in some cases, multiple-choice questions. Whenever multiple-choice questions are included they will require computation to ascertain their correct answers. In as much as is possible, examination questions will seek to have the student apply what he or she has learned to new situations. All examinations are pass/fail.

A "pass" on an examination means that the student has learned the material well enough to be considered minimally competent in the areas dealt with in the minicourse. A failure on an examination indicates that the student has not yet learned the material to a level sufficient to demonstrate minimum competency. A "pass" on an examination also means that a student has responded correctly to 90% of the items on the examination. Finally, a student may take an end-of-course examination over a given minicourse as many times as are necessary to receive a passing grade. However, students will not take two identical end-of-course examinations but different forms of the same examination.

COURSE TIME LINE

The only time limitation is on the overall course. Students may take as long as they desire on individual minicourses, but the course must be completed within one year of the date of initial course registration. Students who are unable to complete the course within this time period may request in writing one six-month

extension. An extension fee will be charged to cover course administration during the extended period (see the sheet listing course enrollment fees). If, at the end of eighteen months, the student has not met the requirements of his or her grading contract, a course final grade will be awarded, based upon the student's accomplishments during the period of enrollment.

MINICOURSE OUTLINES

1. Minicourse D-1: Elementary Background

   A. Substances and Mixtures.
   B. Physical properties of matter (phase, density, solubility, luster, ductility, malleability, tenacity, brittleness).
   C. Classification of Matter (elements, compounds, mixtures).
   D. Nuclear model of the atom (electrons, protons, neutrons).
   E. Electrovalence and covalence.
   F. The Periodic Table, its purpose and its arrangement.
   G. Writing chemical formulas and equations.
   H. Solutions (ions in solution, processes of ionization and dissociation, reactions in solutions).

2. Minicourse D-2: Chemical Reactions

   A. A review of chemical symbols and equations.
   B. Chemical reactions and equations (synthesis, single replacement, exchange of ions, decomposition, combinations of reaction types).
   C. Electronic equations (electrochemical, electrolytic, simple electrode reactions).

3. Minicourse D-3: Quantitative Relationships

   A. Determination of atomic and molecular weights.
   B. The concept of the mole.
   C. The study of simple weight-weight, weight-volume, and volume-volume probelems.

4. Minicourse C-1: Advanced Chemical Reactions

   A. Energy effects in chemical reactions (temperature, heat and its measurement, heat content, heat of reaction, conservation of energy).

B. Rates of reactions (activation energy, catalysis).
C. Equilibrium (open and closed chemical systems, factors affecting equilibrium, equilibrium constants, pH, precipitation).

5. Minicourse C-2: Atomic Theory

A. Spectra, their causes and interpretations.
B. The Bohr model of the atom.
C. Atom shell populations and energy levels.
D. The periodic table and electron configurations.
E. Electron configurations and bonding types.
F. An historical development of man's knowledge of the atom.

6. Minicourse C-3: Solutions

A. The measurement of concentrations.
B. A study of saturation, supersaturation, and the limits of solubility.
C. The numerical aspects of solutions (percent solution, parts per million, grains per gallon, molarity, normality, equivalent weights).
D. Factors affecting solubility.
E. Reactions which occur in solution (acid-base neutralization, pH and its relationship to scale and protective coatings).

7. Minicourse C-4: Corrosion

A. The effects of corrosion.
B. The causes of corrosion (oxygen, carbon dioxide, acid and caustic causes, ammonia stress, velocity, hydrogen, embrittlement).

8. Minicourse B-1: Low Pressure Boiler Water Treatment

A. The need for boiler water treatment, including corrosion prevention, scale prevention, and foaming, and carry-over prevention.
B. Performance of alkalinity, chloride, phosphate, sulfate, hydrazine, total dissolved solids, and soap hardness tests.

9. Minicourse A-1: High Pressure Boiler Water Treatment

A. Constraints of high pressure systems.
B. The coordinated phosphate theory.
C. Special trace element tests.
D. Special analytical methods.
E. Automated systems.

10. Minicourse E-1: Organic Chemistry

A. The characteristics of carbon.

B. Structural formulas.
C. Classification of organic compounds (aliphatic, aromatic, substitution products).

11. Minicourse E-2: Toxic Substances

A. Classification of toxic substances.
B. Examples of the physiological effects of each of the classes of toxic substances (corrosive, metabolic, neurotoxic, mutagenic, carcenogenic).
C. Halucinogens.

12. Minicourse E-3: Water Pollution and Waste Treatment

A. Natural water purification.
B. Pollution types (thermal, sewage, fertilizers, syndets, pesticides, industrial wastes, silt).
C. Water purification (common municipal systems, hard water, sea water, distillation, freezing, hydrate formation, ion exchange, electrodialysis, reverse osmosis).

Minicourses R-1 through R-5 are not discussed here. They are remedial in nature and available for those students who encounter mathematics difficulties as they proceed through the various other minicourses. They may not be used as elective minicourses.

PROCEDURES

The list of procedures is an outlined review of much of the information presented above. These procedures outline the student's stepwise progression through "An Introduction To The Fundamentals Of Chemistry For The Marine Engineer."

1. The student registers for Ch-1C.

2. The student submits a grade contract.

3. The student proceeds through the study of a minicourse.

4. The student locates a proctor for the end of minicourse examination.

5. The student requests that a given minicourse examination be sent to his or her proctor.

6. The student takes the end-of-course examination.

7. If necessary, the student takes additional examinations over a given minicourse.

8. The student proceeds to the study of the next minicourse.

9. The student completes the course in twelve (12) months (eighteen (18) months if an extension is granted).

MATERIALS

The following list of materials include all of those specifically intended for use with the course. Some must be renewed each time a new student enrolls in the course, while others can be used for multiple course administrations.

1. One 35mm slide projector.
2. One audio cassette tape player.
3. One slide carousel.
4. One set of 35mm slides for each of the respective minicourses.
5. One minicourse study guide for each of the respective minicourses.
6. One tapescript for each of the respective minicourses.
7. One laboratory equipment package.
8. One chemical package.
9. One student text package.
10. One supplementary text package.

STUDENT TEXT PACKAGE

1. Brown, T. H., and LeMay, H. E., Chemistry - The Central Science. Englewood Cliffs, New Jersey: Prentice & Hall, Inc., 1977.
2. Hill, J. C., Students' Guide To Brown and LeMay Chemistry - The Central Science. Englewood Cliffs, New Jersey: Prentice & Hall, Inc., 1977

SUPPLEMENTARY TEXT PACKAGE

1. Ameroid Engineer's Manual Of Marine Boiler And Feed Water Treatment. Parsippany, New Jersey: Drew Chemical Corporation, 1975.

2. Ameroid Marine Water Treatment. Parsippany, New Jersey: Drew Chemical Corporation, 1967.

3. Ameroid Chemical Analysis Of Water. Parsippany, New Jersey: Drew Chemical Corporation, 1976.

4. Bull & Roberts Chemicals And Instrumentation. Murray Hill, New Jersey: Bull & Roberts, Inc., 1977.

5. Magnus Maritec Practical Water Treatment For Marine Boilers. Edgewater, New Jersey: Magnus Maritec International, Inc.